



TITLE:

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CITATION:

YAMAGIWA, Juichi ...[et al]. Population Density and Ranging Pattern of Chimpanzees in Kahuzi-Biega National Park, Zaire: A Comparison with a Sympatric Population of Gorillas. African Study Monographs 1992, 13(4): 217-230

ISSUE DATE:

1992-12

URL:

<https://doi.org/10.14989/68096>

RIGHT:

POPULATION DENSITY AND RANGING PATTERN OF CHIMPANZEES IN KAHUZI-BIEGA NATIONAL PARK, ZAIRE: A COMPARISON WITH A SYMPATRIC POPULATION OF GORILLAS

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ABSTRACT A population census of chimpanzees (*Pan troglodytes schweinfurthii*) was conducted in the original part of Kahuzi-Biega National Park, Zaire. The census provides the first estimate of the density of chimpanzees in montane forests of Equatorial Africa. At least three unit groups of chimpanzees were identified in the census area during the 1990 bamboo season. The estimated density (0.13 chimpanzees/km²) falls within the range of densities in savanna, the driest chimpanzee habitat. The estimated density was far lower than the density of gorillas that sympatrically inhabit this montane forest, even though the two apes have been found at almost equal density in tropical forests in other areas. Chimpanzees were typical forest-dwellers, but gorillas ranged over various types of vegetation, including the open vegetation and the swamp. The low diversity and availability of fruits in the montane forest are responsible for the low density of chimpanzees who are frugivorous in various habitats. At least five out of eight primate species raided crops around the borders of the park. Chimpanzees raided maize and plantain bananas. The hostility of the local people towards these primates has recently become heightened in this area. More international attention is needed to augment conservation activities and to protect these primates from the hazards of human disturbances in this area.

Key Words: Chimpanzees; Montane forest; Population density; Ranging pattern; Conservation.

INTRODUCTION

Chimpanzees are distributed from Senegal to Tanzania in Equatorial Africa. Censuses and studies have been conducted on chimpanzees in different habitats, such as the savanna (Suzuki, 1969; Izawa, 1970; Kano, 1971; 1972; McGrew et al., 1981; Baldwin et al., 1982), the woodland (Goodall, 1965; 1968; Nishida, 1968; Nishida & Kawanaka, 1972), the medium-altitude forest (Reynolds & Reynolds, 1965; Sugiyama, 1968; Ghiglieri, 1984) and the tropical forest (Jones & Sabater Pi, 1971; Tutin & Fernandez, 1984; 1985). Chimpanzees are regarded as typical as forest-dwellers; they exhibit frugivorous characteristics while occasionally feeding on animal matter, such as insects and mammals in all habitats.

Nishida (1972) noted the presence of chimpanzees in the bamboo bush of Mt. Mahale in Tanzania, and Albrecht (1976) suggested that the distribution of chimpanzees actually extends to the Ruwenzori forest in Uganda. In eastern Zaire, chimpanzees were also found from the tropical to montane forests (Rahm, 1965, 1966; Rahm & Christiaensen, 1963; Mwanza & Yamagiwa, 1989). However, reliable information is scant on chimpanzees in montane forests. Bolwig (1959) and Schaller (1963) provided the only reports on the vertical distribution and construction of beds by chimpanzees and gorillas in the montane forest of Kayonza, Uganda. This limited information prevents us from reconstructing the evolution of chimpanzees through an analysis of their abilities to adapt to different environments, and from developing optimal strategies for their conservation in the wild.

The Kahuzi-Biega National Park includes tropical and montane forests, in which chimpanzees and gorillas live sympatrically. A preliminary survey of their ecological characteristics has been in progress since 1987 (Yamagiwa et al., 1992a; Mwanza et al., 1992). Conservation activities of IZCN (Institut Zairois pour Conservation de la Nature) recently have been augmented and improved with the cooperation of GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit). In order to examine the effects of conservation efforts and to determine a plan of action for further steps in conservation, it is necessary to obtain basic data about the presence of both chimpanzees and gorillas within the park.

We conducted a census in the original site of the park (montane forest) in 1990. The aim of our census was to obtain reliable information on the density and ranging pattern of chimpanzees in this area, in comparison with those of gorillas. The estimated density of chimpanzees was compared with that in other allopatric and sympatric habitats of gorillas, in relation to the chimpanzee ability to adapt to different environments.

METHODS

The census was conducted between September and November 1990 in the original site of Kahuzi-Biega National Park, Zaire (Fig. 1), which was first established as a Forest Reserve in 1960 and became a National Park in 1970 for the protection of the gorillas (Mankoto, 1988). It covers an area of 600 km² between

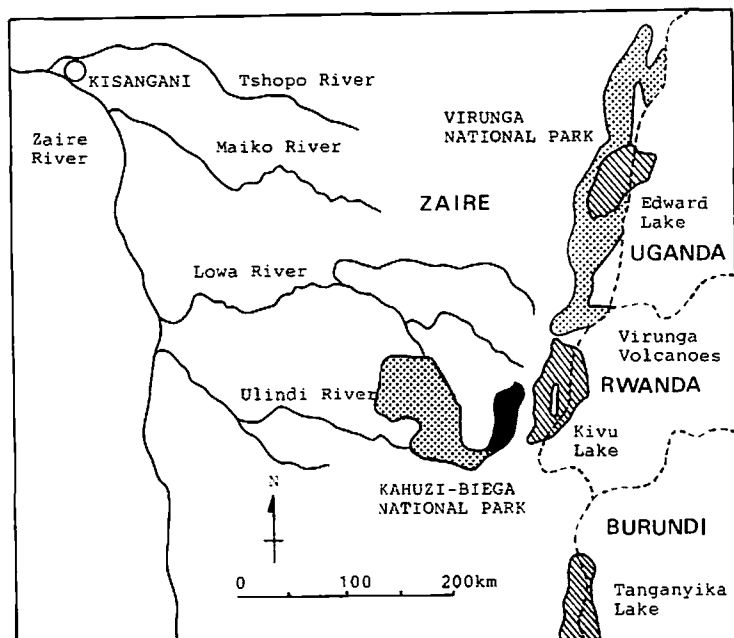


Fig. 1. Map showing the two National Parks (dotted areas) in eastern Zaire and the original site (black area) of Kahuzi-Biega National Park.

the altitudes of 1,800 to 3,308 m and composed of bamboo (*Arundinaria alpina*) forests (37%), primary montane forests (28%), secondary montane forests (20%), *Cyperus* swamps (7%) and other vegetation (8%), as described by Goodall (1977) and Murnyak (1981).

The topography of the census area is mountainous, with well-forested slopes. Several large, flat areas are covered by *Cyperus* swamps. Bamboo forests consisting mainly of bamboo are found at the altitude of 2,350 to 2,600 m, and mixed bamboo/primary or secondary montane forest (mixed bamboo forests) are found at the altitudes of 2,200 to 2,350 m. Subalpine vegetation appears at the altitudes of 2,600 m. *Erica arborea*, *Senecio* sp. and *Lobelia* sp. are found as dominant species on the top of Mt. Kahuzi (3,308 m). Primary montane forests cover the western and northern parts, and secondary montane forests cover the eastern part of the park. Dominant species of trees in each type of vegetations are *Podocarpus* sp., *Ficus* sp. and *Symphonia globulifera* in the primary montane forests; *Hagenia abyssinica*, *Myrianthus holstii* and *Vernonia* sp. in the secondary montane forests; and *Hypericum revolutum* and *Rapanea melanophloeos* in the *Cyperus* (*Cyperus latifolius*) swamps (Casimir, 1975; Goodall, 1977). *Symphonia globulifera* and *Syzygium guineense* are also found in and around the swamps. Tree ferns (*Cyathea manniana*) are found on wet slopes and in valleys. Herbs, vines and ferns (*Urera hypselodendron*, *Basella alba*, *Lactuca* sp., *Pteridium africana*, etc.) constitute the dense terrestrial vegetation in the secondary forest.

From annual rainfall records at the Meteorological Station in the census area

(Casimir & Butenandt, 1973), a year can be divided into four seasons: the short dry season, January-March; the long rainy season, March-June; the long dry season, June-September; and the short rainy season, September-December. Bamboo shoots are only available in the short rainy season. The fruits of *Myrianthus holstii* and *Syzygium guineense* are available in large amounts during the long dry season and during the short rainy season, respectively.

The census was made during the bamboo season. The census area was divided into four sectors, and three groups consisting of researchers, park guards, and field assistants walked simultaneously through each sector, mainly in bamboo forest (Fig. 2). Since the main purpose of the census was to collect data on the presence of gorillas within the park, the census did not cover the western half of the Northern Sector, where the park guards had patrolled periodically during the days prior to the census and found no evidence of the presence of gorilla.

We tried to find fresh gorilla trails (up to two days old) and to follow them to the night bed sites, simultaneously recording field signs of any recent mammalian or human activity. We also recorded the sites of vocalizations emitted by any mammal, and tried to count the number of individuals in groups whenever we en-

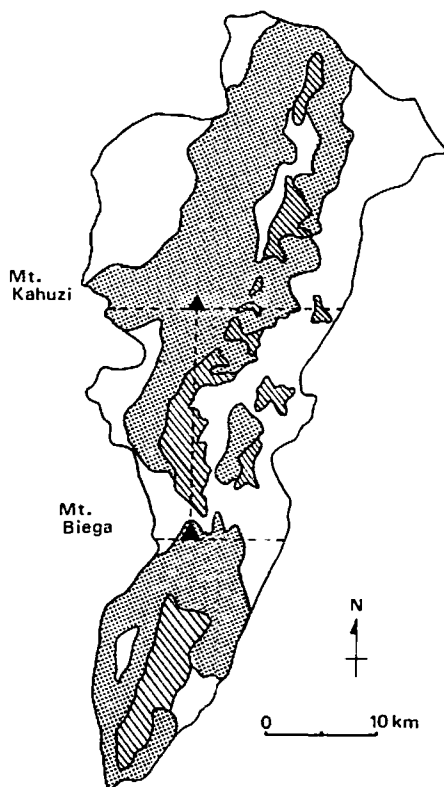


Fig. 2. Map of vegetation in the Kahuzi-Biega National Park and the four sectors in which the census was conducted. Dotted areas, bamboo forests including the mixed bamboo forest; hatched areas, *Cyperus* swamps; white areas within the park, primary or secondary montane forests.

countered them. Night beds built by chimpanzees were distinguishable from those of gorillas on the basis of their construction and the feces in and around them. We examined beds and feces as thoroughly as possible, and counted new beds (up to one week old) to estimate of group sizes.

Because of the fission and fusion common in chimpanzee unit groups (Nishida, 1968), it is difficult to estimate the size of each unit group. Chimpanzees tend to form temporary parties of various sizes in different habitats (Goodall, 1965; Reynolds & Reynolds, 1965; Sugiyama, 1968; Izawa, 1970; Baldwin, et al., 1982). Baldwin et al. (1982) reported that the largest parties observed had been estimated by researchers to represent various percentages of the community (unit group): 60% in Budongo Forest (Sugiyama, 1968), 64% in Gombe National Park (Teleki, 1977), 81% in Budongo Forest (Suzuki, 1971) and 100% at Filabanga (Itani & Suzuki, 1967). Sugiyama (1981) also reported the formation of cohesive unit groups of chimpanzees and pointed out that their party sizes represented more than 50% of the total unit group size in 50% and 80% of his total encounters during two study periods at Bossou, Guinea. Thus, we estimated the largest party size from bed counts and direct observations and regarded this size as representing at least 60 % of the unit group size.

For an estimate of party size, we selected the maximum number of beds in an area where we found new bed sites within a distance of 10 km of each other. Each bed belonging to the same bed site. Located within a distance of 50 m from the nearest neighboring bed was defined as solitary beds, which were built more than 50 m away from the nearest beds, were excluded from the count.

From July to September 1991, we observed a semi-habituated unit group of chimpanzees on a daily basis and counted their night beds in the south-eastern part of Sector A. The maximum number of beds counted ($N=5$; range=8 to 11) represented about 50 % of the largest party size ($N=5$; range=16 to 22) of chimpanzees observed feeding in fig trees on the same days. Thus, we regarded the maximum number of bed counts as representing 50 % of the largest party size in each area.

RESULTS

I. Population Density

During the census, we found 18 new bed sites (up to one week old) of chimpanzees. These new bed sites may possibly have belonged to three different unit groups (Fig. 3). The maximum number of beds in each unit group was 4, 6 and 8, respectively. Thus, if these numbers represent 50 % of the largest party size of each group, the actual largest party sizes were 8, 12 and 16, respectively. If we regard the largest party size as representing about 60 % of the unit group, the number of individuals in the three unit groups were 13, 20 and 27, respectively. The estimated population size is:

Density = 60 (total number of individuals in three unit groups)/ 450 km^2 (the census area)

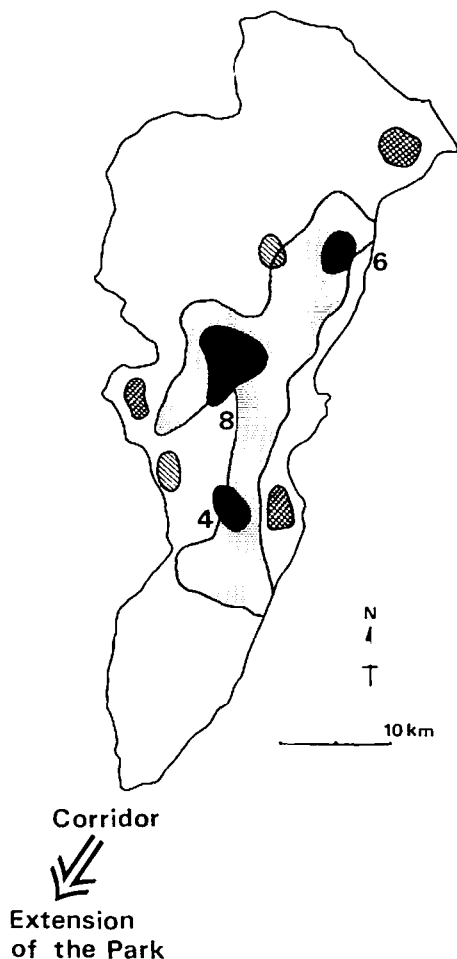


Fig. 3. Ranging areas of chimpanzees and gorillas during the census. Numbers indicate the maximum number of beds counted in each area. Black areas in which fresh field signs and beds of chimpanzees were found; hatched areas, areas in which only old beds of chimpanzees were found; dotted areas, areas in which fresh field signs and beds of gorillas were found; cross-hatched areas, areas in which only old beds of gorillas were found.

= 0.13 chimpanzees/km².

During the same period, we counted 258 gorillas within the park (Yamagiwa, et al., 1992b). The estimated size of the population was between 258 and 284, and the population density within the park was 0.43–0.47 gorillas/km². The population density of gorillas was far higher than that of chimpanzees in the census area. However, since the park guards occasionally encountered chimpanzees in the western half of Northern Sector, where the census was not conducted, the actual difference in the density between the two apes may be smaller than indicated by the results of the census.

II. Ranging Patterns

Fresh field signs and new bed sites of chimpanzees were only found around the border between the primary or secondary montane forests and the bamboo forests or swamps. Although field signs were occasionally found, no bed was found in swamps. Bamboo shoots were eaten by chimpanzees along the edges of the bamboo forests, but no field signs or beds were found deep inside bamboo forests.

New bed sites of chimpanzees were located at altitudes from 2,150 to 2,370 m (Table 1). Few field signs were found in the bamboo zone (2,350–2,600 m) and no sign was found in the subalpine vegetation. Among 18 bed sites, nine sites were located in primary forests, eight in secondary forests, and only one in bamboo forests.

All chimpanzee unit groups were located within or near the range of the gorillas (Fig. 3). New bed sites of gorillas were also located at almost the same altitudes (2,170–2,400 m) as those of chimpanzees. However, gorillas ranged extensively in the mixed bamboo forests where they were seeking and feeding on bamboo shoots during this season, while chimpanzees ranged mostly in the primary or secondary montane forests.

Among old beds of gorillas and chimpanzees that could be distinguished by their construction, we selected beds that had been possibly built during the long dry season (June–September). Figure 3 shows the location of bed sites that may possibly have been built in the long dry season, and Table 1 shows the altitudes and types of vegetation at which they were found. Both gorillas and chimpanzees ranged at nearly the same altitudes in both rainy and dry seasons. However, in both cases the animals tended to range in different areas in the two seasons. This tendency towards a seasonal change in range use was more pronounced for gorillas than for chimpanzees. We rarely found old bed sites of gorillas within their range during rainy season (the census period), and only one old site was located near (within a distance of 20 m) their new bed sites. By contrast, five old beds of chimpanzees were found among 18 new bed sites. Gorillas frequently ranged in secondary forests in the long dry season and shifted their range to bamboo forests, while chimpanzees ranged in primary and secondary montane forests in both seasons. These observations suggest difference in the usage of vegetation between chimpanzees and gorillas within the park.

Table 1. Altitudes and types of vegetation at sites of new or old beds of chimpanzees and gorillas.

	No. of bed sites	Altitude Mean (Range)	P	No. of bed sites in each type of vegetation		
				S	B	Sw
New (Rainy season)						
Chimpanzees	18	2,232 m	9	8	1	0
Gorillas	31	(2,150–2,370)	9	3	18	1
Old (Dry season)						
		2,255 (2,170–2,400)				
Chimpanzees	22		9	12	1	0
Gorillas	24	2,193 (2,040–2,390)	8	12	4	0
		2,224 (1,960–2,410)				

P: Primary montane forest, S: Secondary montane forest, B: Bamboo forests (mixed with primary or secondary forest), Sw: Swamp.

III. Poaching Activity

In 1978–79, several chimpanzees were directly observed in Southern Sector (Yamagiwa, personal observation). However, we found no evidence of the presence of chimpanzees in Southern Sector during the census. Thus, it appears that the chimpanzees recently ceased to live in this area. In the 1991 long dry season (just before the census period), the presence of chimpanzees and gorillas were confirmed in the corridor (about 40–50 km south-west from Southern Sector) between the highland and the lowland forests in the new extension of the park (Refisch, 1991).

In the central area, where the park guards patrol frequently and tourists visit several groups of gorillas on a daily basis, gorillas and chimpanzees are well protected. However, in the northern and southern areas the number of guards is small and the guards cannot patrol the whole area. During the census we found more traps, remains of camp fires, hunting camps and new trails made by poachers in these areas than in the central area. The infrequent patrols failed to reduce poaching activity and, thus, chimpanzees were probably stimulated to shift their range to the more protected areas.

Poaching activity was more severe outside the park. In and around the original site of the park, we found eight species of primates during the census. Local people said that at least five out of these eight species often raided crops near the border of the park (Table 2). Baboons raided most kinds of crops, but *Colobus* monkey and gorillas, who are specialized folivores, did not raid crops. Chimpanzees raided maize and plantain bananas which constitute the major foods of local people. These raiding primates came from the dense forest in the park and periodically entered the cultivated fields, in particular, near the western border of the park. Hunting and capturing of primates are strictly prohibited in and around the park by the government of Zaire. However, recent deforestation and the replacement of these areas by cultivated fields with an increase in the local population near the park have made the local people hostile towards the raiding primates. A conservation policy is urgently needed in order to improve these situa-

Table 2. Crops raided by primates outside the original part of Kahuzi-Biega National Park.

Primate species	Crops raided by primates							
	Ma	Co	Po	Ca	Pl	Su	Pe	Be
<i>Cercopithecus mitis</i>			+		+			+
<i>Cercopithecus lhoesti</i>				+	+			
<i>Cercopithecus hamlyni</i>	+							
<i>Colobus badius</i>								
<i>Colobus angolensis</i>								
<i>Papio anubis</i>	+	+	+		+	+	+	+
<i>Pan troglodytes</i>	+				+			
<i>Gorilla gorilla</i>								

+: Crops raided by primates.

Ma: Maize, Co: cocoyam, Po: potato, Ca: cassava, Pl: plantain banana, Su: sugarcane, Pe: peanuts, Be: beans.

tions in this area.

DISCUSSION

The density of chimpanzees, as estimated by our census, was very low (0.13 chimpanzees/km²) compared to densities reported for other areas (Table 3). Although it is difficult to compare densities among various habitats because the various censuses used different census techniques, such as nest counts, line-transect censuses, scouting or head counts, our estimate of density is similar to the densities of chimpanzees at Filabanga (0.2/km²) and Ugalla (0.08–0.12/km²) given by Kano (1971, 1972) and at Mt. Assirik (0.09/km²) given by Baldwin *et al.* (1982) in the savanna. Since our census was mainly conducted in bamboo forests, where chimpanzees did not range frequently, the actual density of chimpanzees within the park may well be higher than suggested by the results of the present study. However, it is possible that the density of chimpanzees in montane forests is far lower than that in medium- or low- altitude forests and woodlands.

The densities of chimpanzees have generally been found to be almost same as or slightly higher than those of sympatric populations of gorillas in tropical forests. By contrast, this study showed that the density of chimpanzees was far lower than that of the sympatric gorillas inhabiting the montane forests of Kahuzi-Biega National Park. Since chimpanzees are less than half the size of gorillas, their density should be higher than gorillas if both apes use the same food resources in the mon-

Table 3. Estimated population densities for chimpanzees in various habitats and those for sympatric gorillas.

Country	Site	Habitat	Density (individuals/km ²)		Source
			Chimpanzees	Gorillas	
Zaire	Mt. Kahuzi	Montane forest	0.13	0.43–0.47	This study
Zaire	Itebero-Utu	Tropical forest	0.27–0.33	0.27–0.32	Yamagiwa <i>et al.</i> , 1989
Equatorial Guinea	Mt. Alen & Mt. Okorobiko	Tropical forest	0.31–1.53	0.58–0.86	Jones & Sabater Pi, 1971
Gabon	Nationwide	Tropical forest	0.32	0.18	Tutin & Fernandez, 1984
Uganda	Budongo	Forest	6.7		Sugiyama, 1969
Uganda	Budongo	Forest	6.0		Suzuki, 1971
Uganda	Budongo	Forest	3.4		Reynolds & Reynolds, 1965
Uganda	Kibale	Forest	1.5–2.4		Chiglieri, 1984
Tanzania	Gombe	Woodland	2.5		Wrangham, 1975
Tanzania	Gombe	Woodland	1.4		Goodall, 1968
Tanzania	Mahale	Woodland	1.1–2.0		Nishida & Kawanaka, 1972
Tanzania	Kasakati	Savanna	0.5–0.75		Suzuki, 1969
Tanzania	Kasakati	Savanna	0.3–0.4		Izawa, 1970
Tanzania	Filabanga	Savanna	0.2		Kano, 1971
Tanzania	Ugalla	Savanna	0.08–0.12		Kano, 1972
Senegal	Mt. Assirik	Savanna	0.09		Baldwin <i>et al.</i> , 1982

tane forest. Our results suggest the existence of differences in range use and diet between the two apes and a lower capacity of the montane forest for chimpanzees than for gorillas.

This study showed that gorillas ranged over more types of vegetation than chimpanzees in the montane forest. Gorillas visited all types of vegetation, feeding on fibrous plants and building beds mostly on the ground. By contrast, chimpanzees ranged extensively in primary and secondary montane forests and rarely visited mixed bamboo forests in either season examined. No bed was found in swamps, and no bed was observed on the ground. These results suggest that, unlike gorillas, chimpanzees may not intensively seek out bamboo shoots or use any type of open vegetation for bed-building.

In the tropical forest, the two apes also show different ranging patterns. Chimpanzees tended to range in the primary forest and use the canopy, while gorillas usually ranged in the secondary regenerating forest and used open areas during the wet season in Equatorial Guinea (Jones & Sabater Pi, 1971). In Gabon, although both apes exhibited similar dietary characteristics, a nationwide census found chimpanzees at highest densities in primary forest and gorillas in undisturbed secondary forests and thickets (Tutin & Fernandez, 1984; 1985). In the savanna, chimpanzees rarely moved from the woodland and the gallery forest to the dry open land (Izawa & Itani, 1966; Kano, 1971; Baldwin et al., 1982). The availability of water and cover may well play an important role in shaping the use of habitat (McGrew et al., 1981). With respect to the montane forest, gorillas were reported to range in the subalpine vegetation of the Virunga Volcanoes (Fossey, 1974) and on Mt. Kahuzi (Yamagiwa, 1988), while in this study we found no field signs of chimpanzees above the bamboo zone at Mt. Kahuzi. These findings may suggest that the ranging pattern of chimpanzees is limited to forested areas and, thus, the bamboo forest is their highest habitat in Equatorial Africa.

The low diversity of fruits may be responsible for the low density of chimpanzees in the montane forest. Chimpanzees are frugivorous in various habitats (savanna, Kano, 1971 and Baldwin et al., 1982; woodland, Goodall, 1965 and Suzuki, 1969; tropical forest, Sabater Pi, 1979 and Tutin & Fernandez, 1985; medium-altitude forest, Reynolds & Reynolds, 1965 and Sugiyama, 1969). The Kahuzi-Biega National Park covers the tropical as well as the montane forest where chimpanzees and gorillas live sympatrically. In tropical forests, chimpanzees and gorillas consume many kinds of fruit, although gorillas also consume large amounts of fibrous plants (Yamagiwa et al., 1992a). In the montane forest, chimpanzees regularly consume fruits, such as *Myrianthus holstii* and *Ficus* sp. in the secondary forest during the long dry season, as well as *Syzygium guineense* in and around swamps in the short rainy season. However, the diversity of fruits is very low in this area (Casimir, 1975). Chimpanzees consume fewer kinds of fruit in the montane forest than in the tropical forest (Yamagiwa et al., 1992a). They also feed on ants and have been found to dig out subterranean nests of stingless bees using tools to eat honey and larvae (Goodall, 1977; Yamagiwa et al., 1988). Gorillas have been regarded as almost complete folivores in the montane forest (Casimir, 1975; Goodall, 1977; Yamagiwa, 1988), as reported also in the case of mountain gorillas on the Virunga Volcanoes (Harcourt & Fossey, 1977; Watts, 1984). Dur-

ing the short rainy season, gorillas feed on bamboo shoots and the base of leaves of *Cyperus latifolius*, while these plants are not major food items of chimpanzees. This observation suggests that about half of the census area (bamboo forest and *Cyperus* swamp) may not provide enough food for chimpanzees. Fruits may not constitute a stable food resource for gorillas and chimpanzees in the montane forest. Differences in the availability of fruits between habitats and the food choices of the two apes may be major factors that influence their densities in tropical and montane forests.

This study found no evidence of the presence of chimpanzees and gorillas extensively in the Sector. This area is adjacent to the corridor between the highland and lowland forests of Kahuzi-Biega National Park. Parts of the corridor were untouched by poachers and were still frequented by chimpanzees (Refisch, 1991). However, rampant deforestation and poaching have disturbed the ranging of primates in and around the corridor. Since the two apes exhibited different dietary and ranging patterns in the two habitats, it is important to protect this area to preserve their flexible use of the environment and the possibility of interbreeding.

Raiding of crops by chimpanzees has been reported in many areas of their habitats. In Tanzania, they consume the stalks of sugar-cane and maize, the pith of banana stems, and the nuts of oil palm (Nishida, 1972). In Guinea, they eat rice and millet, and destroy large amounts of grapefruit (Dunnott et al., 1970). They also raid crops in Ivory Coast (Bourlière et al., 1974) and Equatorial Guinea (Jones & Sabater Pi, 1971). Around the census area of eastern Zaire, Rahm (1966) reported that chimpanzees eat the fruit and pith of cultivated banana plants. Our census found that they also raided maize in this area. These findings suggest the extensive use of various foods by chimpanzees in various habitats and warned us of the recent increase in human contacts with them. Eastern Zaire is known for the high population density of humans. Recent immigration from the neighboring countries has raised the population density and accelerated deforestation in this area. These changes in human activities around the border of the park have intensified the struggle between the local people and chimpanzees. In eastern Zaire, gorillas and chimpanzees are found sympatrically in many areas. However, their habitats have been disturbed and destroyed by human activities in many places over the past decades (Mwanza et al., 1988, 1992). More international aid is needed to increase the number of park guards, so that more frequent patrols can provide safe habitats for chimpanzees and gorillas. It is necessary for us to establish optimal methods for the conservation of chimpanzees and gorillas in this region. Another population census and more detailed research is needed in the near future.

ACKNOWLEDGMENTS This study was financed by the Monbusho (Ministry of Education, Science and Culture, Japan) International Scientific Research Program and by a Grant from GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit), in cooperation with CRSN (Centre de Recherches en Sciences Naturelles) and IZCN (Institut Zaïrois pour Conservation de la Nature). We would like to express our thanks to Dr. Zana Ndontoni, Dr. Mankoto ma Mbaelele, Mr. Mankoto ma Oyisenzo, Mr. Ngoro Likuwani, Mr. Mashagiro Menshi, and Mr. Wathaut Wabubindja for their administrative help and hospitality. We

are also greatly indebted to Mr. Ndumbo Bosilana and to all the guides, guards, and field assistants of the Kahuzi-Biega National Park for their technical help and hospitality throughout the field work.

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——— Received July 7, 1992.

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